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THE CHICKASHA SEDIMENT SAMPLER

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THE CHICKASHA SEDIMENT SAMPLER[1]

Gary E. Miller, Paul B. Allen, Norman H. Welch, and Edd D. Rhoades[2]

INTRODUCTION

This publication describes an automatic pumping-type sediment sampler, designed and constructed at the Southern Plains Watershed Research Center, Agricultural Research Service, U.S. Department of Agriculture, Chickasha, Okla. The sampler was developed to implement this Center's mission of determining the effects of upstream flood control treatment on downstream areas.

One of the factors to be considered in designing effective flood control treatments is the effect of land use on runoff and sediment production. Therefore, a number of small watersheds have been established to investigate the effect of land use on hydrologic performance, including erosion rates.

Manual collection of suspended sediment samples from these small watersheds has not been satisfactory. Spring and summer rainstorms in the Southern Plains are often short and intense, and runoff usually follows quickly after a storm begins. Also, most runoff events occur outside normal duty hours. It is almost impossible to be at these watersheds in time to obtain initial samples. The use of an automatic sampler was the only practical method of collecting sediment samples, especially during the initial period of runoff. This led to the development of a sampler particularly suited to the project at Chickasha. The sampler is patterned after the XPS-62 sampler developed by the Federal Inter-Agency Sedimentation Project.[3]

GENERAL OPERATION

Figure 1 shows an overall view of the Chickasha Sediment Sampler. The sampler, capable of collecting up to 28 samples in 12 hours, is powered by an ordinary 12-volt d.c. automotive storage battery. It is activated by a water level sensor (WLS) which may be set at any predetermined stage. With a rise in stage to the preselected level, the WLS closes, permitting electric current to flow from the battery to the timing drive unit (TDU). A timing wheel is attached to the drive, which rotates counterclockwise. The timing interval (or a combination of intervals) can be selected for individual watersheds.

Rotation of the timing wheel by the drive allows the microswitch to drop into the first notch, completing the circuit of the 2-minute timing motor. The sequence of events needed to collect a sample is programed through four cam-operated microswitches attached to the timing motor.

First, the sample bottle tray-advance solenoid is activated, placing a bottle in position to receive a pumped sample. Following the tray advance, the pump motor (M3) operates for approximately 1 minute. During most of this pumping period, flow is discharged back into the stream. This flushes the line of all sediment-laden water from previous pumping. Near the end of the pumping period, the flow diverter control solenoid (RS2) is energized, causing the pumped flow to be discharged into a sample bottle. It takes approximately 4 seconds to fill the sample bottle to the proper level; however, the time may vary because of differences in the pumping head. The pipper, or flow-chart-marking mechanism, is energized at the same time as the flow diverter.

When the sequence of events is completed, the timing motor (M2) is stopped by the cam-operated microswitch (S1). The timing motor is activated again when the sampling frequency switch drops into the next notch on the timing wheel. The sampling procedure is repeated until the tray-drive weight opens microswitch S5 positioned at the lower end of the weight guide tube, stopping the sampler. The WLS will also stop the sampler if the stage drops below the preselected level. When all bottles are filled or when the WLS shuts off the current, the tray is ready to be emptied and reset.

THE PUMPING SYSTEM

The pumping system includes the pump, the intake and discharge tubing, and the diverter mechanism. The

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[2] Hydraulic engineering technician, research hydraulic engineer, research soil scientist, and research agricultural engineer, USDA, Chickasha, Okla.

[3] Investigation of a Pumping Sampler With Alternate Suspended-Sediment Handling Systems, Report Q, Federal Inter-Agency Sedimentation Project, June 1962.

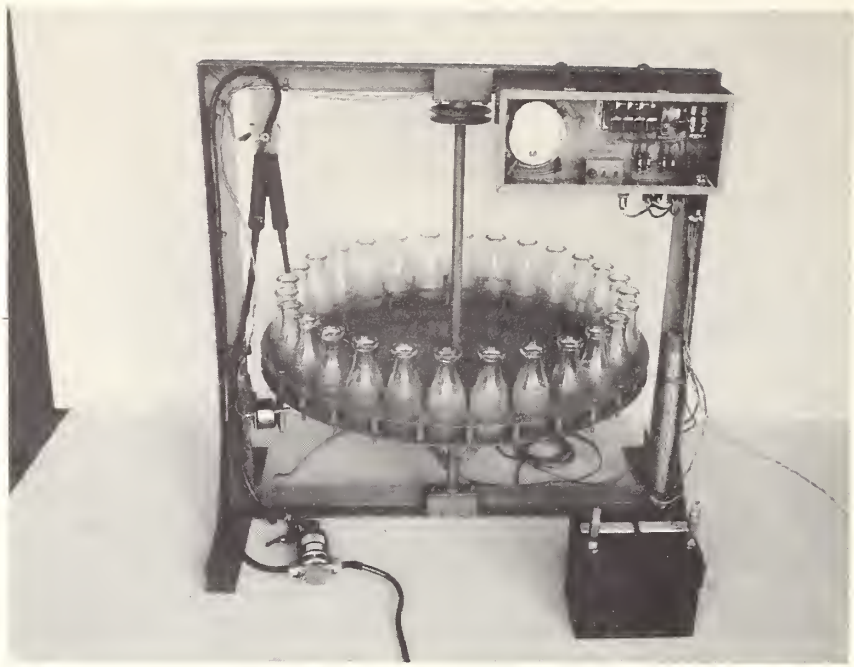


Figure 1.–General view of Chickasha automatic pumping sediment sampler.

intake and discharge lines are made of latex and copper tubing with an inside diameter of 3/8 inch.

The pump, powered by a 12-volt d.c. motor, is small, compact, and self-priming. It will prime satisfactorily at a suction head of up to 6 feet, but some difficulty was experienced when the suction head was greater. The pump should be located near the water surface for ease in priming. If water level fluctuations might submerge the motor, a suitable stationary pump mounting and an airtight protective cover should be used to permit the pump to be located near the normal water surface. (See fig. 2) Should the water level rise above the pump, the air compressed inside the cover will not allow water to reach the electric motor. The pump will operate at a discharge head of up to 23 feet.

THE SAMPLER

The frame supporting the components of the sampler is made of lengths of 2 1/2-inch angle iron welded together as shown in figure 3.

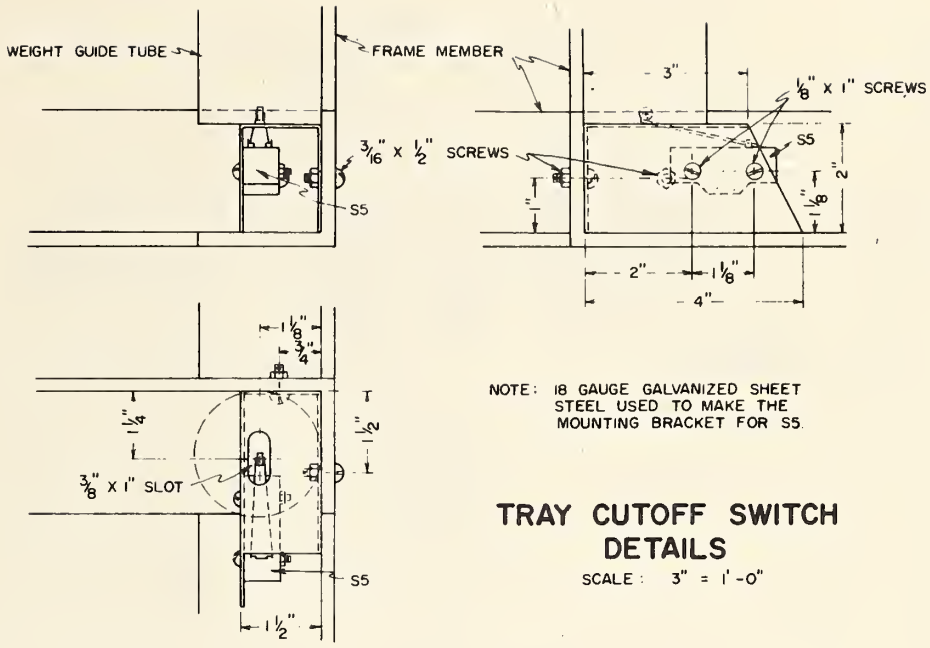
The bottle tray is made by connecting an aluminum plate 36 inches in diameter to a ring of the same diameter. (See fig. 4 for details.) The ring serves as a guide for positioning the bottles. The plate and ring are held together by two circular rows of bolts with aluminum tubing spacers. The outside row of bolts consists of twenty-eight 3-inch by 5/16-inch bolts spaced equally between each bottle position. The extra length of these bolts is an integral part of the tray-advance mechanism.

The tray is held stationary by the leading arm of a tray stop assembly attached to the single-acting tray-advance solenoid. (See fig. 5) When the solenoid is energized, the stop rotates 45° counterclockwise, moving the tray clockwise to allow the leading arm to pass under the end of the 3-inch bolt. The tray-advance weight (shown in fig. 3) then rotates the tray counterclockwise until the lower end of the bolt engages the trailing arm and stops the tray. When the solenoid is de-energized, the tray moves counterclockwise until the end of the next bolt comes in contact with the leading arm of the tray stop assembly.

This procedure advances the tray and positions the bottle to accept the sample to be pumped. The weight that rotates the tray should be positioned to open microswitch S5 when the tray advances from bottle number 27 to bottle number 28, thus stopping operation of the sampler after sample number 28 has been pumped.

Figure 6 shows a layout of the timer, switches, and other electrical components. Figure 7 shows the electrical circuit diagram, the part numbers, and descriptions of all electrical components.

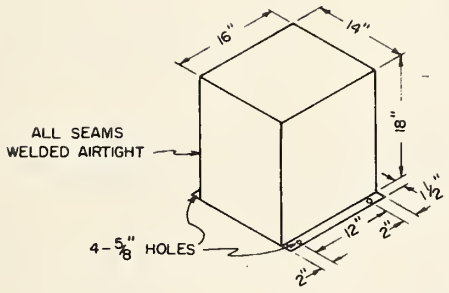
The diverter assembly, shown in figure 8, consists of a solenoid with an adapter that directs the pump

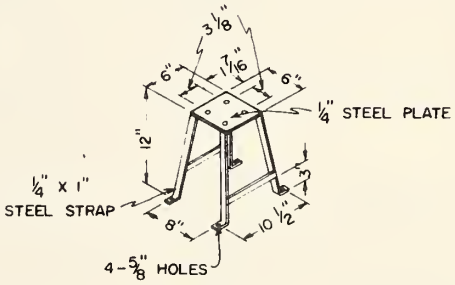


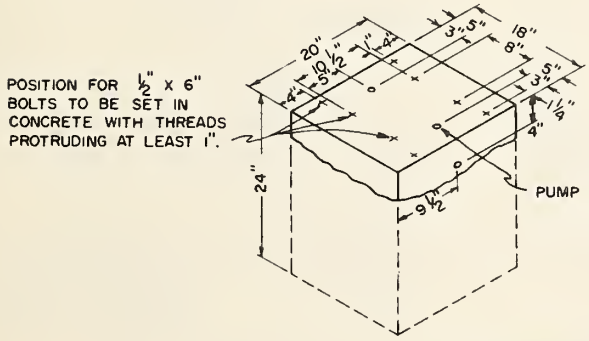
NOTE: 18 GAUGE GALVANIZED SHEET STEEL USED TO MAKE THE MOUNTING BRACKET FOR S5.

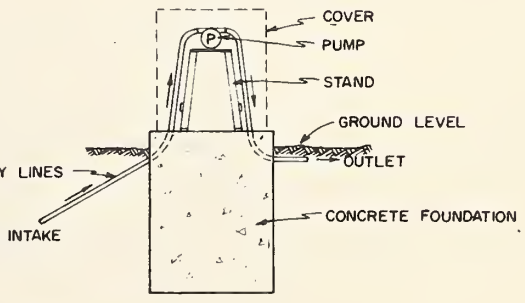
TRAY CUTOFF SWITCH DETAILS

SCALE: 3" = 1'-0"



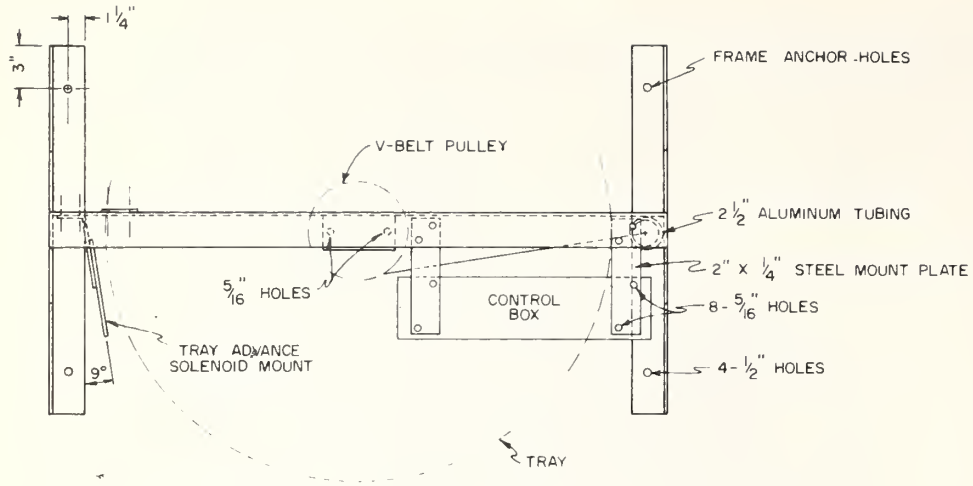




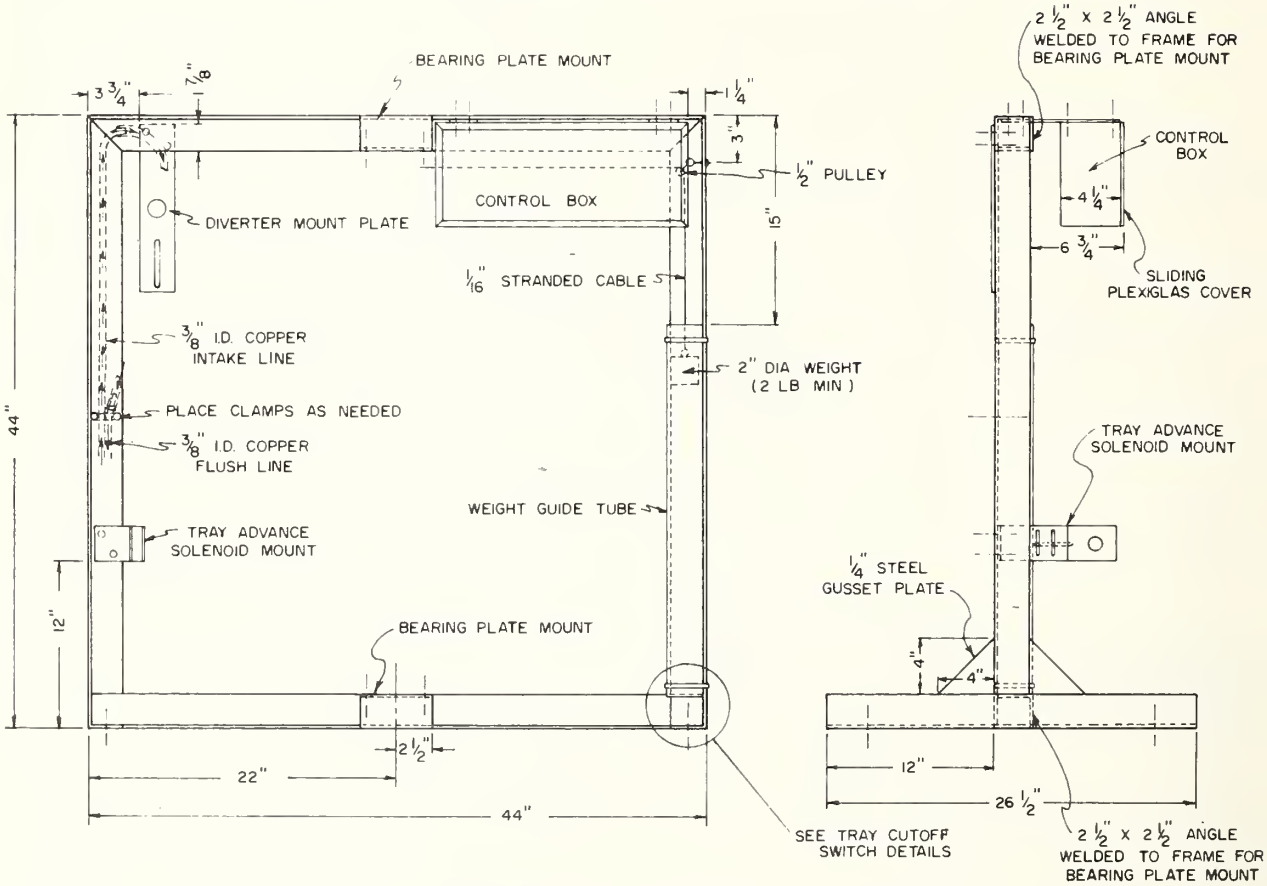


STATIONARY PUMP MOUNT

SCALE: 3/8" = 1'-0"

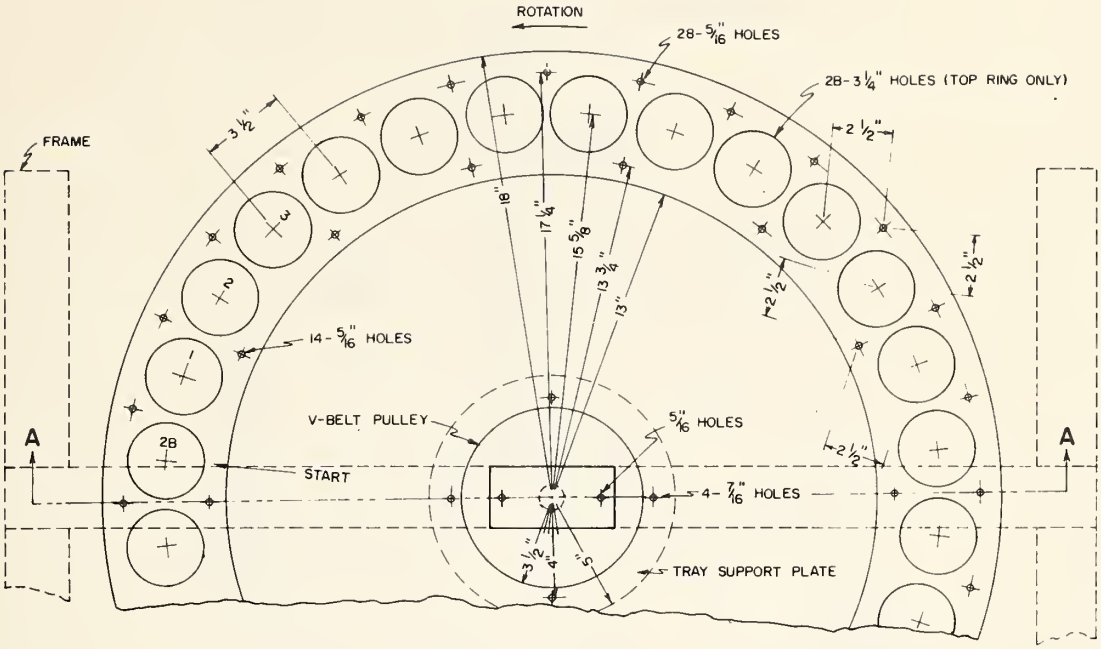


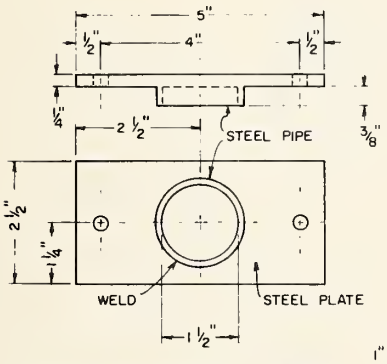
NOTE: ALL FRAME MEMBERS ARE MADE OF 2 1/2" X 2 1/2" X 1/4" STEEL ANGLE



FRAME ASSEMBLY

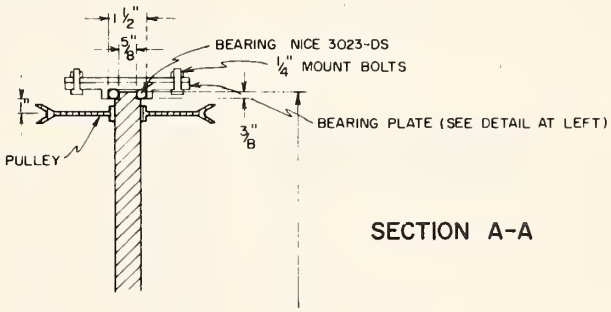
SCALE 3/4" = 1'-0"



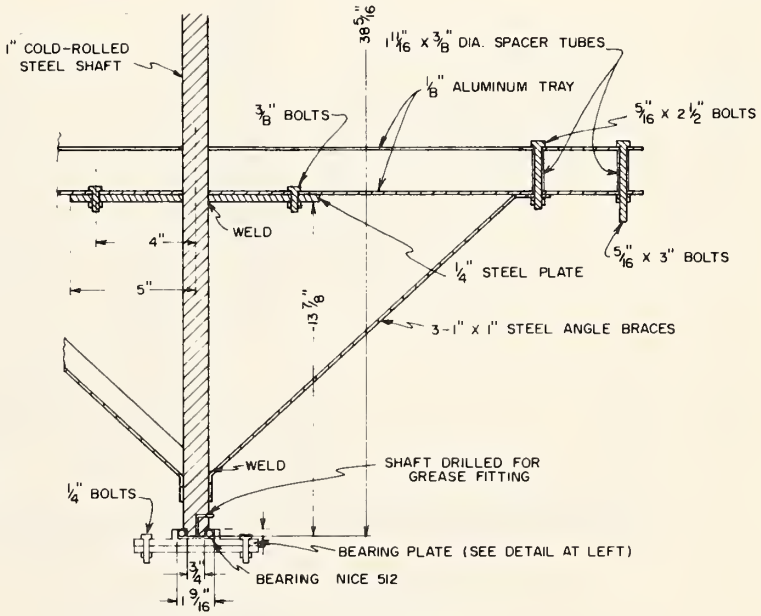


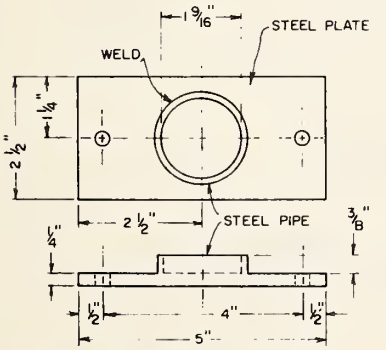
UPPER BEARING PLATE

SCALE : 3" = 1'-0"



SECTION A-A



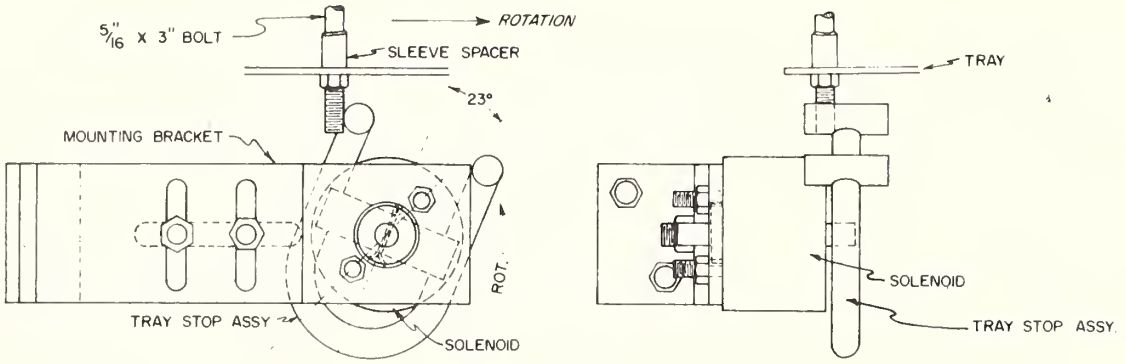


LOWER BEARING PLATE

SCALE : 3" = 1'-0"

TRAY ASSEMBLY DETAILS

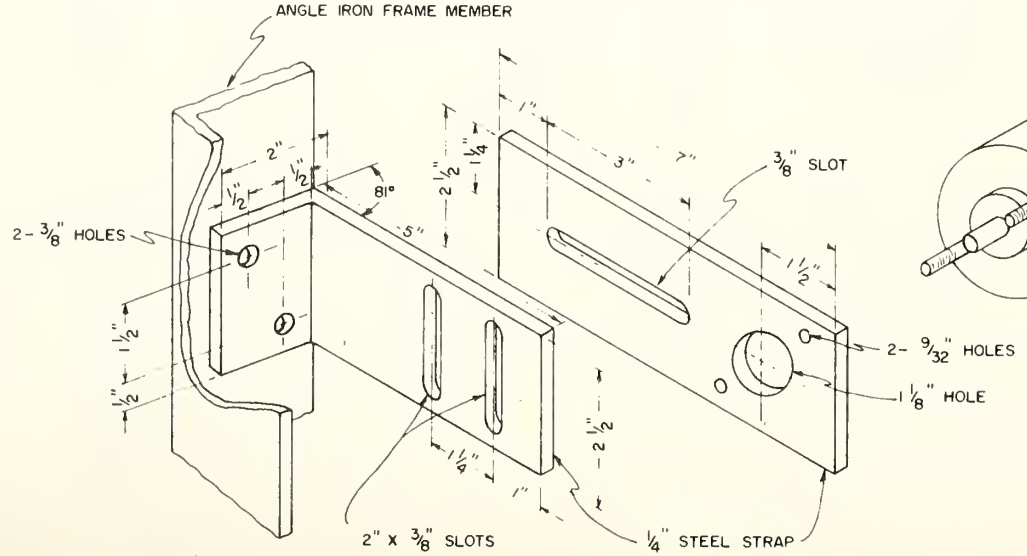
SCALE 1 1/2" = 1'-0"

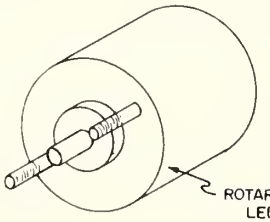


NOTE: SOLENOID SHOWN IN DE-ENERGIZED POSITION

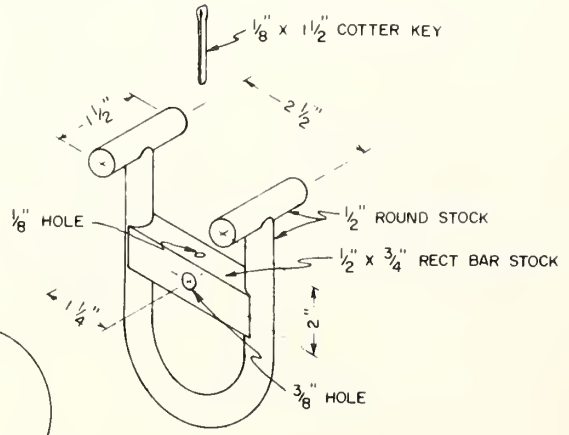
TRAY ADVANCE SOLENOID MOUNT DETAILS

SCALE: 3" = 1'-0"

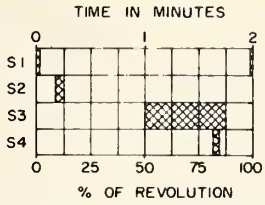




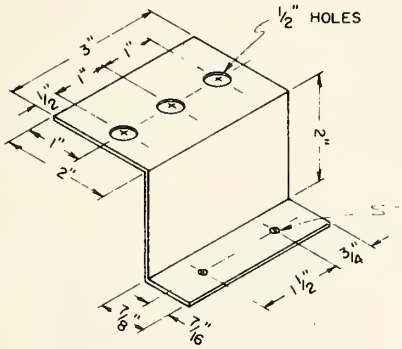
ROTARY SELECTOR SOLENOID
LEDEX, INC S-8210-022



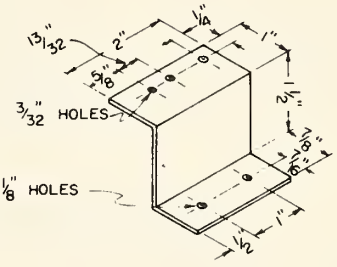
SUGGESTED CAM POSITIONS FOR INDUSTRIAL TIMER



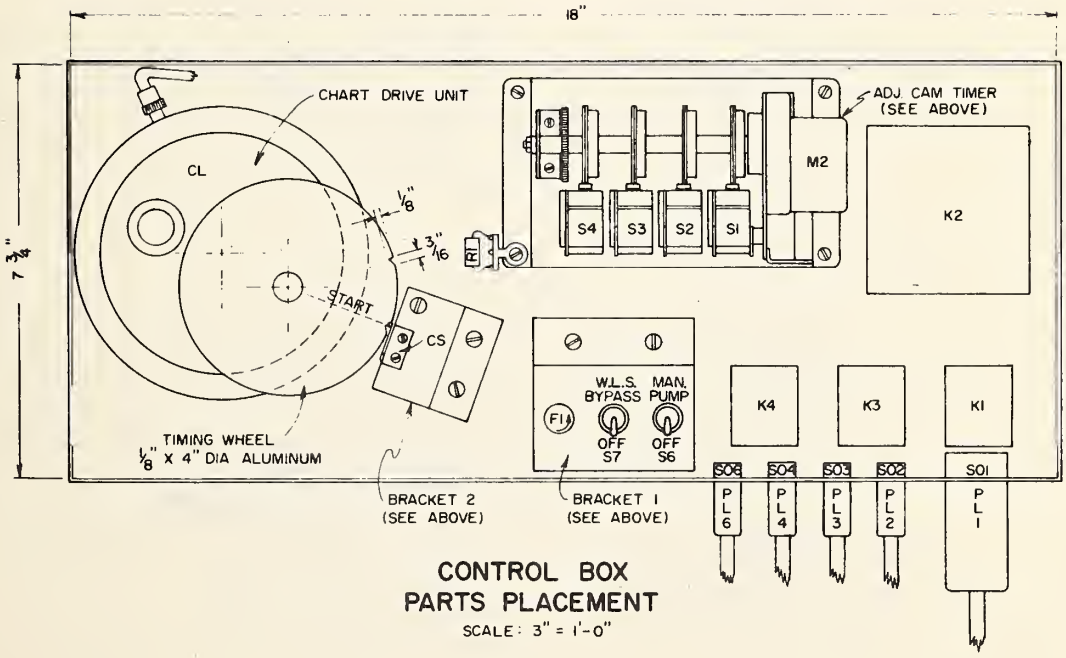
NOTE: POSITION OF SHAFT OF CAM OPERATED SWITCH MEASURED IN PERCENT OF CCW ROTATION VIEWED FROM SHAFT END OF SWITCH.



BRACKET 1
SCALE: 3" = 1'-0"

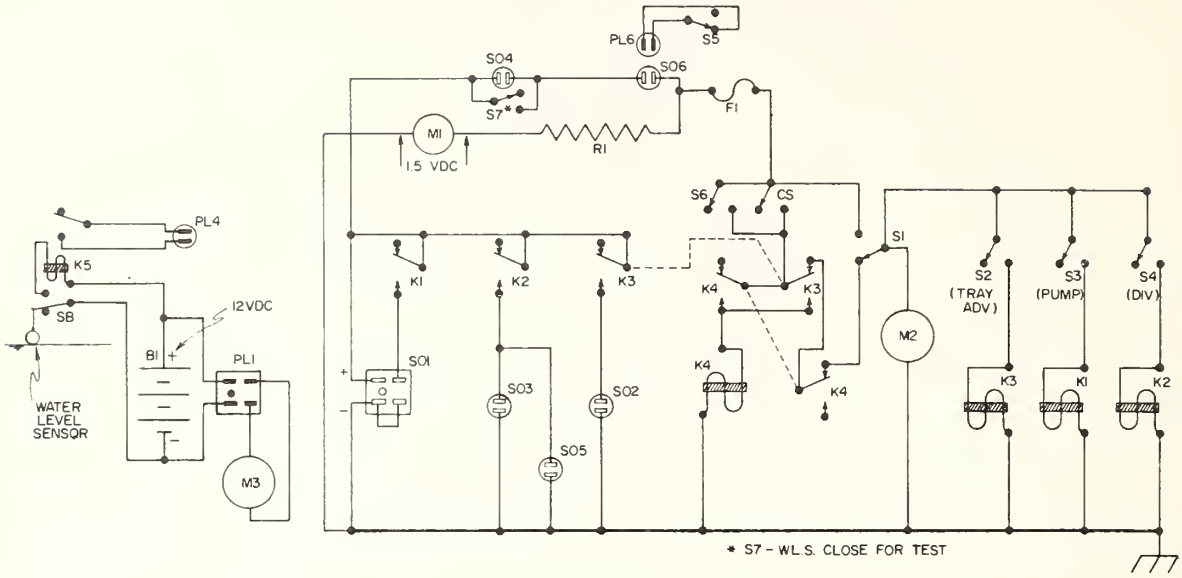


BRACKET 2
SCALE: 3" = 1'-0"



CONTROL BOX PARTS PLACEMENT
SCALE: 3" = 1'-0"

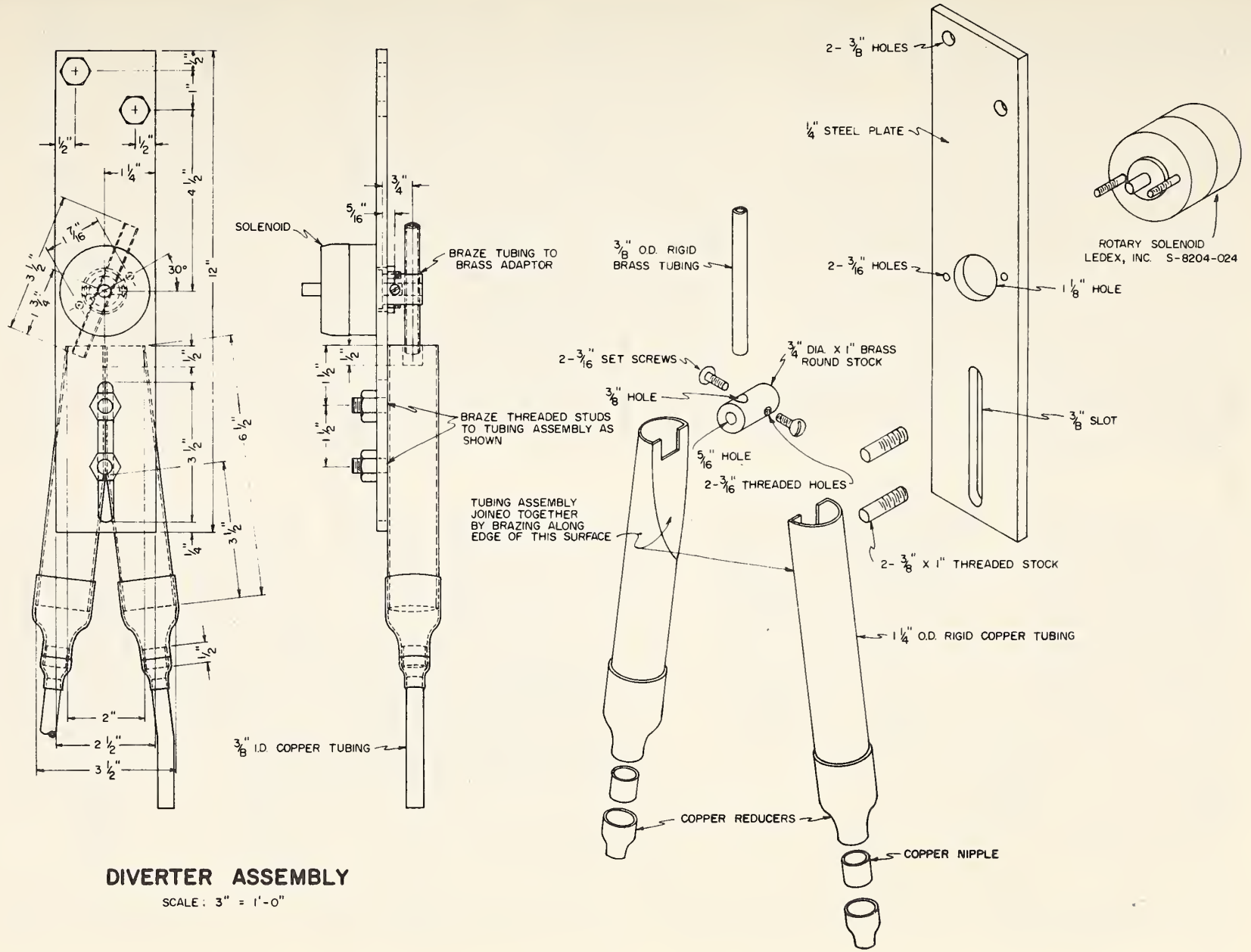
ELECTRICAL SCHEMATIC



ELECTRICAL PARTS SPECIFICATIONS

NOTATION	FUNCTION	DESCRIPTION
K1	TRAY ADVANCE RELAY	POTTER & BRUMFIELD KA11DG-12VDC
K2	PUMP RELAY	POTTER & BRUMFIELD PR11DY-12VDC
K3	DIVERTER RELAY	POTTER & BRUMFIELD KA11DG-12VDC
K4	TIMING MOTOR RELAY	POTTER & BRUMFIELD KA11DG-12VDC
K5	WATER LEVEL SENSING RELAY	POTTER & BRUMFIELD RS5D-12VDC
S01	POWER & PUMP CIRCUIT	JONES TYPE SOCKET S404-AB
S02	TRAY ADVANCE CIRCUIT	JONES TYPE SOCKET S302-AB
S03	DIVERTER CIRCUIT	JONES TYPE SOCKET S302-AB
S04	WATER LEVEL SENSING CIRCUIT	JONES TYPE SOCKET S302-AB
S05	CHART PIPPER CIRCUIT	JONES TYPE SOCKET S302-CCT
S06	AUTOMATIC SAMPLER CUTOFF CIRCUIT	JONES TYPE SOCKET S302-AB
PL1	POWER & PUMP CIRCUIT	JONES TYPE PLUG P404-CCT
PL2	TRAY ADVANCE CIRCUIT	JONES TYPE PLUG P302-CCT
PL3	DIVERTER CIRCUIT	JONES TYPE PLUG P302-CCT
PL4	WATER LEVEL SENSING CIRCUIT	JONES TYPE PLUG P302-CCT
PL5	CHART PIPPER CIRCUIT	JONES TYPE PLUG P302-CCT
PL6	AUTOMATIC SAMPLER CUTOFF CIRCUIT	JONES TYPE PLUG P302-CCT
B1	BATTERY	AUTOMOTIVE TYPE, 12VDC, 85 AMP
R1	CARBON RESISTOR	100 OHM, 2 WATT
F1	FUSE	BUSS TYPE MDL 3 AMP IN HKP BUSS HOLDER
S1	TIMING MOTOR SWITCH	SWITCHES LOCATED IN INDUSTRIAL TIMER (SEE M2)
S2	TRAY ADVANCE SWITCH	
S3	PUMP SWITCH	
S4	DIVERTER SWITCH	
S5	AUTOMATIC SAMPLER CUTOFF SWITCH	ROBERT SHAW 271-003-2-00
S6	MANUAL PUMP SWITCH	TWO POST SINGLE THROW TOGGLE SWITCH**
S7	MANUAL W.L.S. BYPASS SWITCH	TWO POST SINGLE THROW TOGGLE SWITCH**
S8	WATER LEVEL SENSOR SWITCH	ROBERT SHAW 271-003-2-00
CS	SAMPLING FREQUENCY SWITCH	ROBERT SHAW ZLD-0037
CL	FREQUENCY TIMING DRIVE	MERCURY INSTRUMENTS CHART DRIVE-MODEL 99
M1	CLOCK REWIND MOTOR	CONTAINED IN CHART DRIVE UNIT (CL)
M2	TIMER MOTOR	INDUSTRIAL TIMER CORP, MODEL MC-4, 12VDC (4 SWITCH TYPE WITH A-12 GEAR RACK)
M3	PUMP MOTOR	WESTERN BRASS WORKS, MODEL 3MPU 'PONY' 12 VDC
RS1	TRAY ADVANCE CONTROL	LEDEX ROTARY SOLENOID S-B210-022
RS2	DIVERTER CONTROL	LEDEX ROTARY SOLENOID S-B204-D24
RS3	CHART PIPPER CONTROL	LEDEX ROTARY SOLENOID S-B204-024

** SPRING RETURN TYPE



DIVERTER ASSEMBLY

SCALE : 3" = 1'-0"

discharge to a tubing assembly containing two outlets. The tubing assembly permits the discharge to be wasted or to flow into one of the sample bottles. It consists of two 6 1/2-inch lengths of 1 1/4-inch rigid copper tubing, brazed as shown in the drawings. Each piece is flattened slightly on one end, providing a flat surface where the two tubes are joined. A 1/2-inch square notch is cut in the flattened portion of the tubes to allow movement of the tube attached to the single-action solenoid. Two mounting bolts are brazed onto the tubing assembly.

The solenoid adapter is made from a 1-inch length of brass rod 3/4 inch in diameter. A 5/16-inch hole is drilled lengthwise through the brass rod to receive the solenoid shaft. Two 3/16-inch set screws hold the rod onto the solenoid shaft. A 3 1/2-inch length of tubing with an outside diameter of 3/8-inch is inserted through a 3/8-inch hole drilled through the outer end of the brass rod. The tube is brazed in place and the upper end connected to the pump discharge line by a flexible hose connection. The pump discharge will return to the stream when the solenoid is de-energized, and will be diverted into a sample bottle when the solenoid is energized.

The timing wheel (fig. 6) fits snugly over the shaft of the timing drive unit (TDU). The ferruled nut supplied with the drive mechanism holds the wheel in place. Because the threads on the nut are recessed, the nut must be modified by cutting 3/32 inch off its retaining end to allow it to tighten firmly against the timing wheel. Twenty-eight small notches are machined into the periphery of the wheel, one for each sample. The radial spacing of the notches controls the sampling frequency. A timing interval of less than 10 minutes would require a larger timing wheel, because of the space needed to machine the notches. A study of hydrographs and sediment concentrations of previous stream rises can guide the selection of a sampling frequency for a particular station.

Collection of samples at 10-minute intervals required a slight modification of the sampling frequency switch (SF), because notches could not be cut close enough together when using a switch with a 3/16-inch roller. This modification consisted of removing the 3/16 inch in diameter activator roller by cutting the bronze roller with small diagonal cutters. The roller retaining pin was used as the activator roller. Drag caused by this change is of little significance.

A water level sensor (WLS), used to start and stop the sampler, consists of a float, a nylon-covered suspension steel wire, and a microswitch (S_8), as shown in figure 9. The WLS may be installed in an existing gage well if there is enough room, or in a separate well. The microswitch should be mounted in a sheltered place above the expected high water level. One end of the wire is attached to the arm of the microswitch and the other is attached to a float, which must be heavy enough to open the microswitch. As the water level rises, the weight of the float is removed, causing the microswitch to close and complete the circuit to the sampler. The float is positioned at the elevation selected for the sampler to begin operating. This elevation is adjusted by attaching crimped fittings at the desired elevations to the wire attached to the microswitch arm. A small slot sawed in the end of the microswitch arm permits the float to be raised or lowered to any desired elevation.

A second type of WLS that may be used consists of a waterproof mercury switch mounted in the arm of a Styrofoam float. As the water raises the float, the mercury switch closes and completes the circuit to the sampler.

A third type of WLS may be used with a water stage servo-manometer (bubble gage). A microswitch is mounted on an adjustable bracket to the lower left of the mercury well which travels up and down on the threaded shaft. Another bracket with rounded ends and a flat, smooth surface facing the microswitch roller is mounted on the mercury well bracket. The microswitch is then adjusted up or down so that it will close at a predetermined water stage.

The chart marker (pipper) shown in figure 9 should be used with an FW-1 or A-35 water stage recorder when a float-tape system is used. It consists of a rotary solenoid with a T-shaped bar mounted on the solenoid shaft. When the solenoid is energized, the T-bar strikes the float tape, causing the ink pen to move approximately 1/4 inch. Each time a sample is taken, a pip is made on the water level chart. The pip is used in plotting the sediment concentration after the samples have been analyzed.

A single-point intake suction line is used to collect samples from the flow. The intake is covered with a wire mesh screen to prevent trash from being sucked into the pump. The intake should be located so that as representative a sample as possible is collected.

The completed sampler should be housed in a relatively dust-free structure.

The cost of the Chickasha sampler in 1968 was approximately $600, including $350 for materials and $250 for labor.

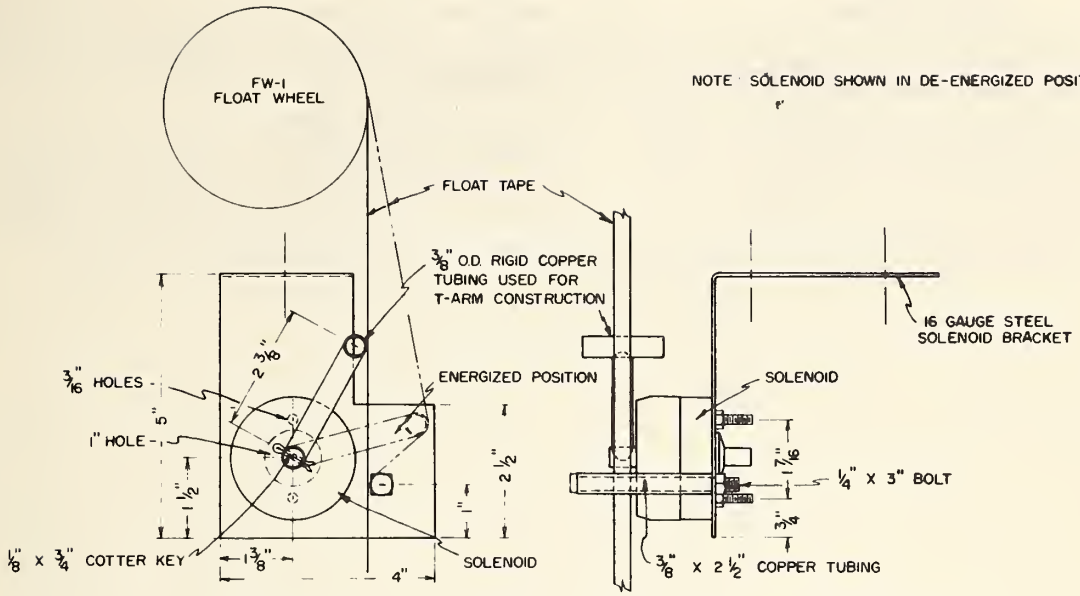
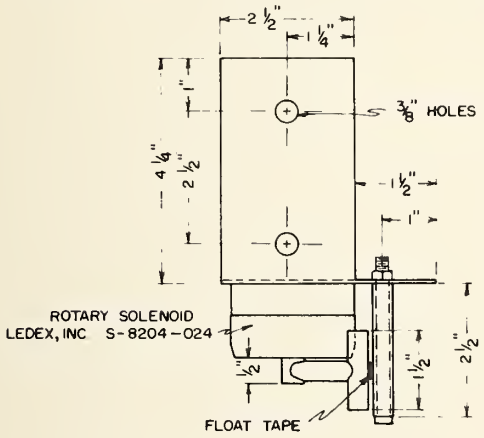
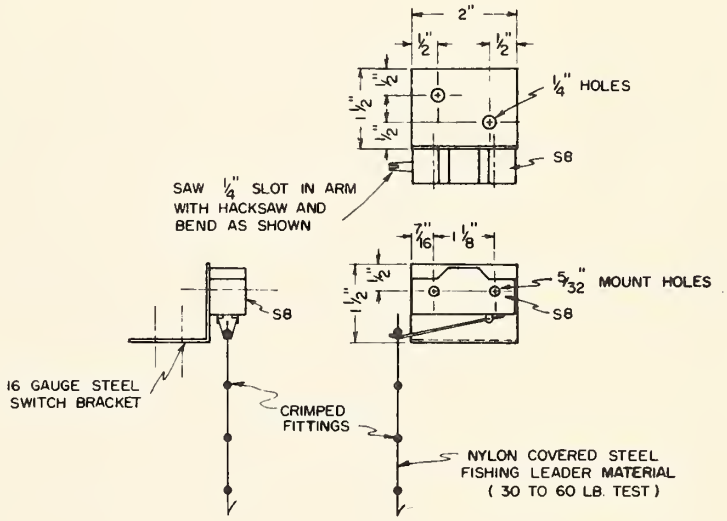


CHART MARKER ASSEMBLY

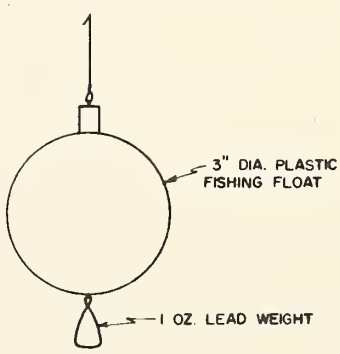
SCALE: 3" = 1'-0"




1/4" HOLES
S8
SAW 1/4" SLOT IN ARM WITH HACKSAW AND BEND AS SHOWN
5/32" MOUNT HOLES
S8
S8
16 GAUGE STEEL SWITCH BRACKET
CRIMPED FITTINGS
NYLON COVERED STEEL FISHING LEADER MATERIAL (30 TO 60 LB. TEST)

WATER LEVEL SENSOR ASSEMBLY

SCALE: 3" = 1'-0"



CONCLUSIONS

The Chickasha sampler has proved to be effective and reliable for taking sediment samples automatically. Automatically pumped samples can mean the difference between a sedimentation record for a given runoff event or none at all.

The 85-ampere-hour battery specified in figure 7 will retain sufficient charge to operate the sampler in a standby mode for approximately 45 days. The battery should be checked periodically with a hydrometer and recharged when the electrolyte S.P.G. drops to 1150.

Various types of pumps have been tested with this sampler. The pump specified in figure 7 has proved to be the most satisfactory of the types tested; however, other pump and motor combinations with comparable electrical and pumping capacities could be used.

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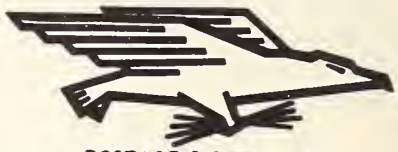

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